

The Nuclear Materials Management and Safeguards System

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Declarations, Verification, and Disposition Tracking

Quantitative Nuclear Materials Management
for Surplus Plutonium

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Summary

- The United States has designated at least 61.9 metric tons (MT) of plutonium (Pu), mostly weapons-grade – that is under Department of Energy or Department of Defense control – to be Excess to potential use in weapons
- NNSA developed a program to provide disposition for up to 40 MT through a dilute-and-dispose technique and seeks to gain maximal monitoring in partnership with IAEA
- Current Excess is tracked by the NMMSS system and its designations, characteristics, locations, and program ownership are reported both internally and internationally
- The “Surplus Fissile Material Baseline” was established in 2000 and needs significant updating
- Verification using new measurements cannot cover the entire Excess inventory, including Pu already disposed or consumed, and can be supplemented by Nuclear Materials Control & Accountability (NMC&A) and NMMSS
- New techniques and protocols may be desirable based on changes to NMC&A procedures for waste and other disposition materials

Excess/Surplus Plutonium Declarations

61.9 metric tons of Pu: Declared, Identified, Tracked, and Reported

Nuclear Weapons Council/Presidential Declaration 1994

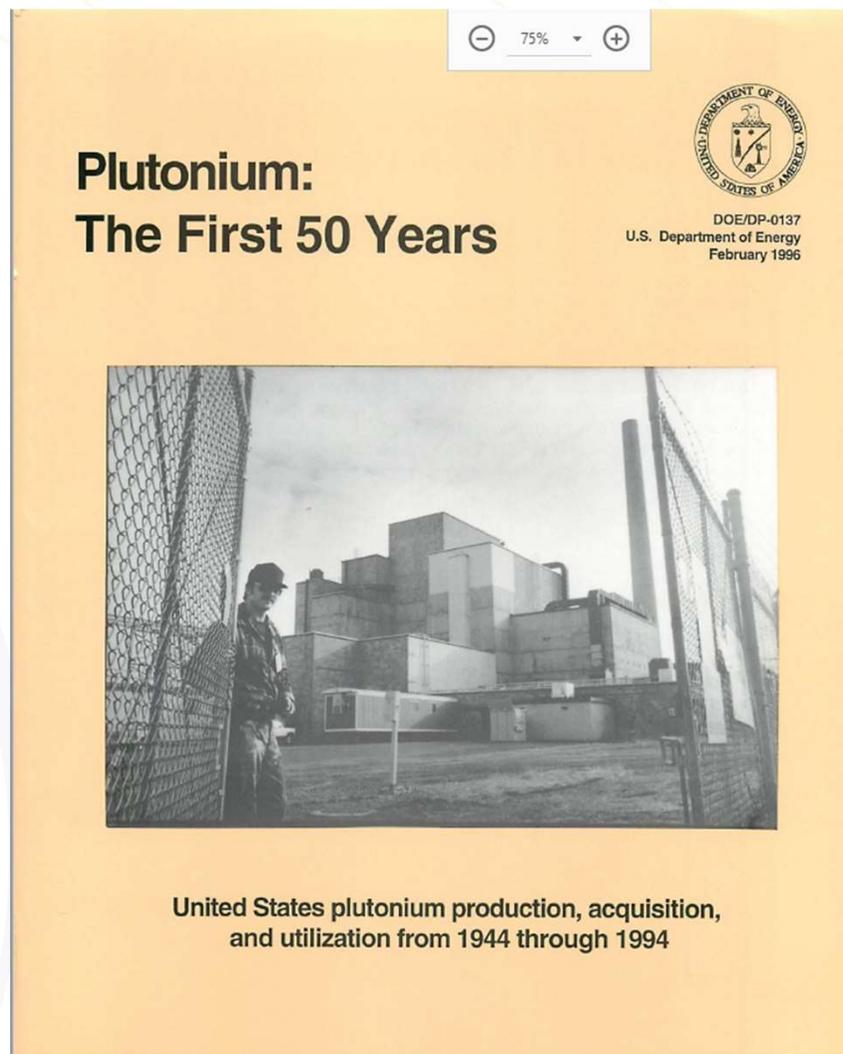


March 1995 speech at Nixon Center for Peace and Freedom

“To further demonstrate our commitment to the goals of the [Nuclear Nonproliferation] Treaty today I have ordered that 200 tons of fissile material -- enough for thousands of nuclear weapons -- be permanently withdrawn from the United States nuclear stockpile. It will never again be used to build a nuclear weapon.”

- 38.2 metric tons (MT) weapons-grade Pu
- 174 MT of highly enriched uranium
- Based on 09/30/1994 U.S. inventory

Plutonium: The First 50 Years



Coverage for Plutonium: The First 50 Years

1. Executive Summary
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 4. DOE Facilities
 5. Summary of Previously Released Data
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 7. DOE/DoD Plutonium Inventory
 8. Historical Plutonium Material Balance
 9. Plutonium Acquisitions
 - Government Production Reactors
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 10. Plutonium Removals
 - Expended in Wartime and Nuclear Tests
 - Inventory Differences
 - Waste (Normal Operating Losses)
 - Fission and Transmutation
 - Decay and Other Removals
 - U.S. Civilian Industry
 - Foreign Countries
- Appendix A: Excess Weapon Grade Plutonium
Appendix B: Plutonium Waste

Figure 4
Location Of DOE/DoD Plutonium Inventory
(September 1994 - Metric Tons)

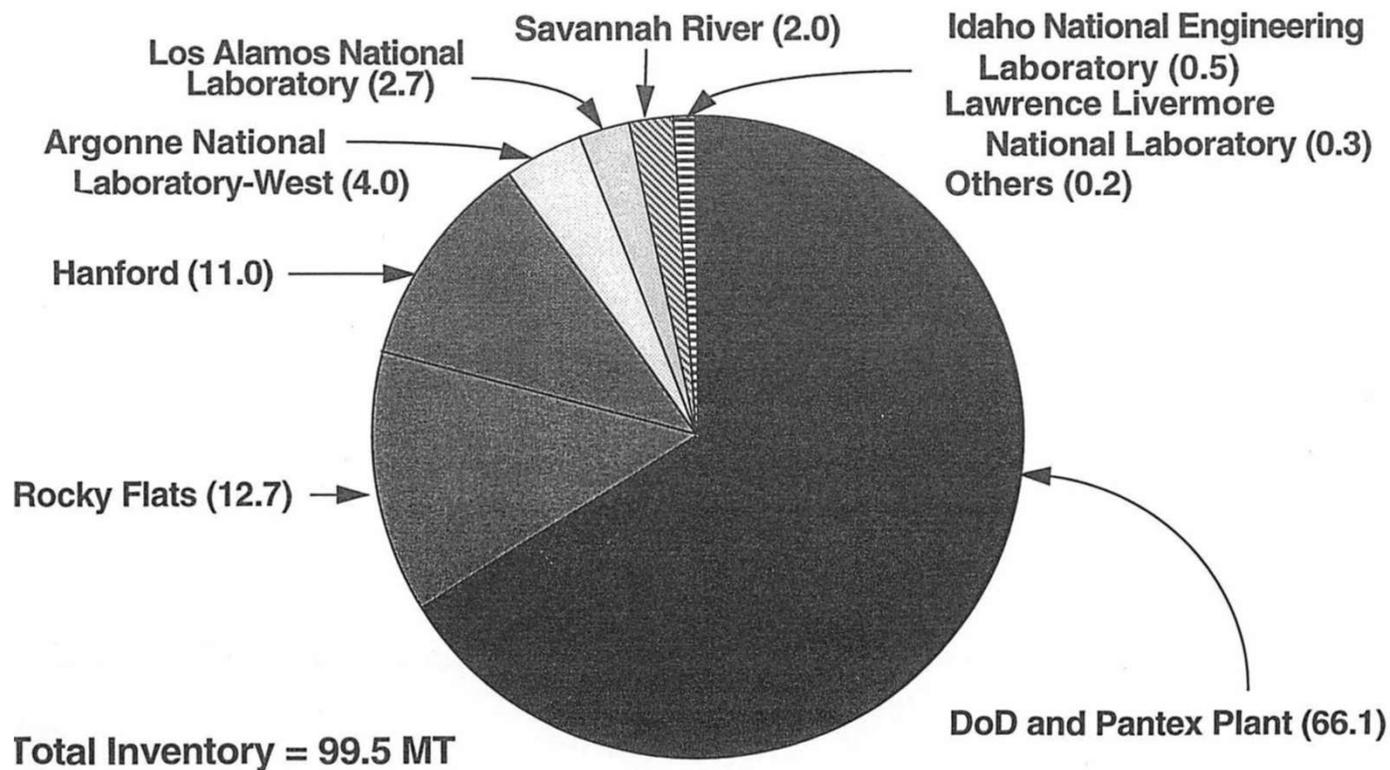


Table 15. Excess Weapon Grade Plutonium (MT Pu)

Locations as of 09/30/1994

Location	Metal	Oxides	Reactor Fuel	Irradiated Fuel	Other Forms	Total
Pantex /future dismantlements	21.3	-	-	-	-	21.3
Rocky Flats	5.7	1.6	-	-	4.6	11.9
Hanford Site	<0.1	1.0	-	0.2	0.5	1.7
Los Alamos	0.5	<0.1	<0.1	-	1.0	1.5
Savannah River	0.4	0.5	-	0.2	0.2	1.3
INEL	<0.1	-	0.2	0.2	<0.1	0.4
Other Sites	<0.1	-	-	<0.1	<0.1	0.1
Total	27.8	3.1	0.2	0.6	6.4	38.2

Note: Totals may not add due to rounding to the nearest tenth of a metric ton.

Most is now at Pantex or SRS. A separate update to *Plutonium: The First 50 Years* was published in 2011, reflecting end-of-FY2008 inventories and progress in consolidation pending disposition.

1996 Identification of Excess Non-Weapons Grade Plutonium



Openness Initiative Fact Sheets

In Fact Sheets for the Openness Initiative, Secretary Hazel O'Leary identified that non-weapons-grade Pu would be managed with similar restrictions to excess weapons-grade

- 14.3 MT of non-weapons grade
- “Excess” means fissile material in declarations or similar actions
- “Surplus” means Excess that has no programmatic use within the Department of Energy
- $38.2 \text{ MT} + 14.3 \text{ MT} = 52.5 \text{ MT}$ became the quantity we track as “S94”

2007 Declaration of Additional Pu from Weapons Programs



Secretary of Energy Announcement to IAEA
General Assembly, Sept. 17, 2007

In 2007, Secretary Bodman announced that an additional 9 MT of Pu would be removed, in the future, from further use as fissile material in nuclear weapons

- Presumed to be associated with retired pits, designated “E07”
- Total 52.5 MT + 9.0 MT = 61.5 MT Excess
- Nearly 1 MT under DOE control that was not in the 09/1994 inventory (from overseas in Global Threat Reduction Initiative and additional Excess), currently 0.4 MT “Excess – Other (“EOT”).

Office of Fissile Materials Disposition (OFMD)



DOE, soon NNSA, stood up OFMD, under
(now) Ambassador Laura Holgate

OFMD chose a “hybrid” strategy for disposition of up to 50 MT of Pu outside spent fuel

- 33 MT nominal to Mixed Oxide Fuel Fabrication, from pits and clean non-pit Pu
- 17 MT nominal to Immobilization via can-in-canister

U.S.-Russian Pu Management and Disposition Agreement (PMDA)

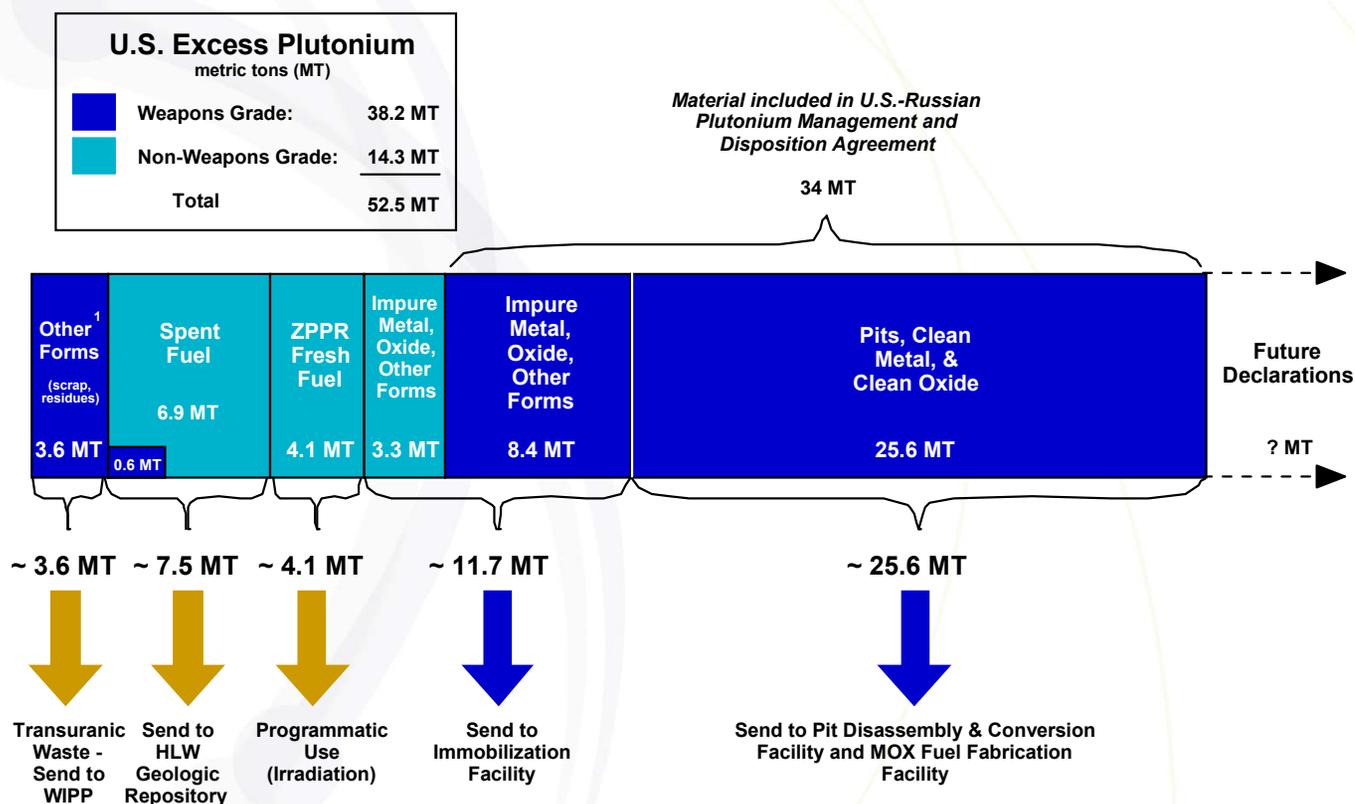


Under Secretary Ernest Moniz & Valentin Ivanov, First Deputy Minister of ROSATOM

In 2000, the U.S. and Russian Federation signed an agreement for each to disposition 34 MT of Excess weapons-grade Pu

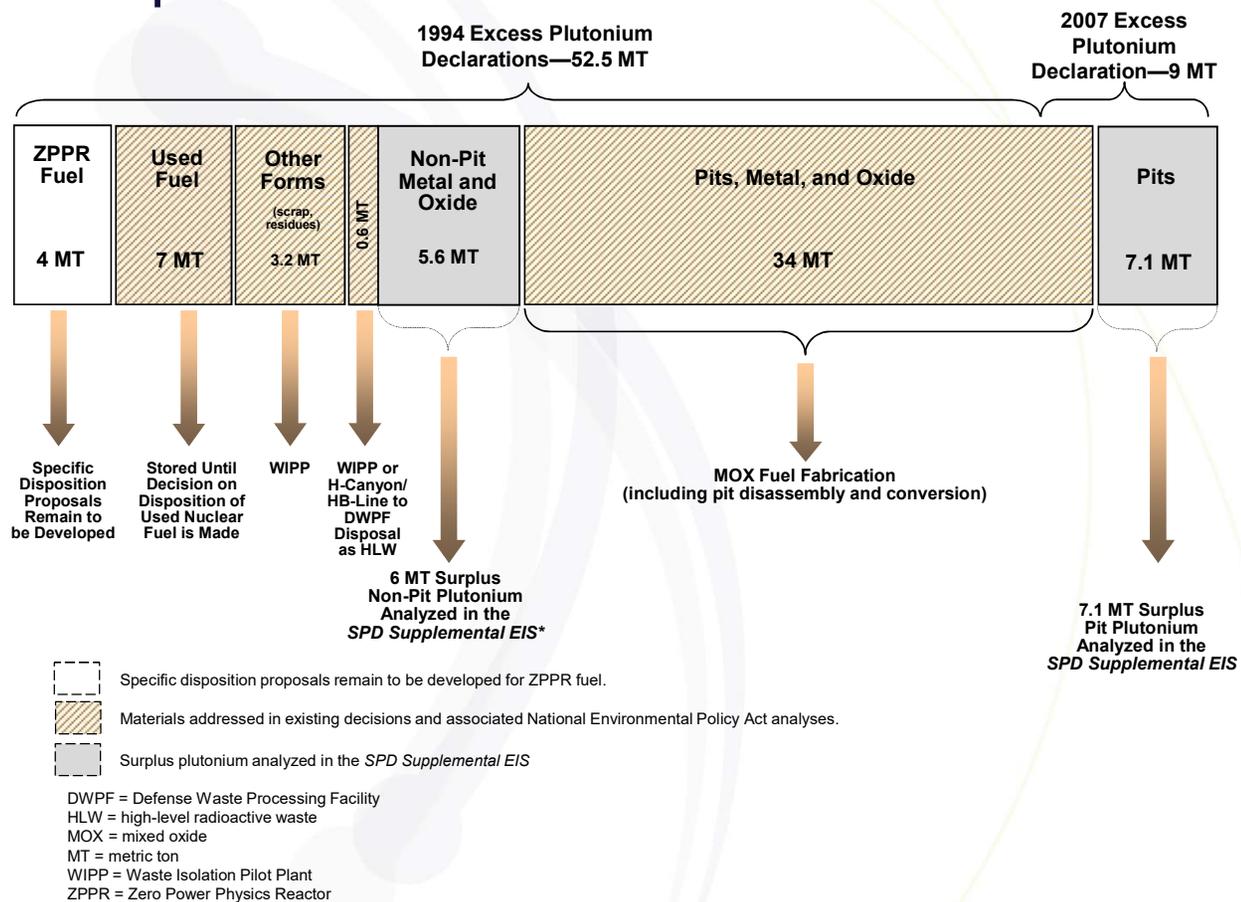
- U.S.: 25.6 MT derived from pits + clean metal to MOX, 8.4 MT to Immobilization
- Revised 2010: U.S. plan changed to 34 MT to MOX
- Russia has purportedly unilaterally suspended the agreement
- Note: “Weapons-grade” follows IAEA boundaries of $<\sim 9.0\%$ ^{240}Pu , instead of $<7.0\%$ of traditional U.S. tracking (Material Type Codes 51 and 52)

Plutonium Disposition Plan - 2001



¹ Some of this material is currently under evaluation & may ultimately be immobilized

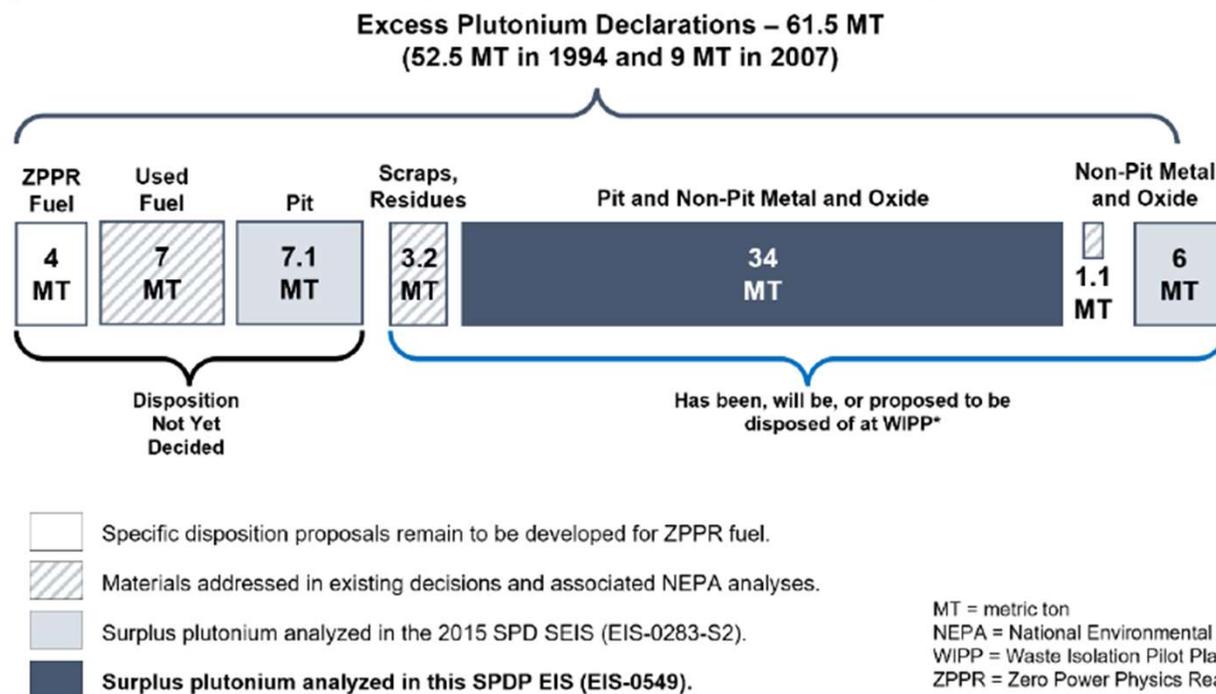
Plutonium Disposition Plan - 2015



*The analyzed quantity of non-pit plutonium is somewhat larger than the existing non-pit plutonium currently identified as surplus to allow for possible future needs to provide disposition paths for surplus non-pit plutonium.

Current Baseline for Surplus Plutonium Disposition

- Final EIS; Record of Decision issued 4/19/2024
- 34 MT that was previously identified for MOX fuel is now identified for “dilute and dispose” process at Savannah River Site (SRS) K-Area, also known as “U.S. commitment” or “NNSA” Pu
- Previously in 2016, up to 6 MT of Pu outside of pits (mostly non-weapons-grade) identified for downblending and transfer to Waste Isolation Pilot Plant (WIPP)



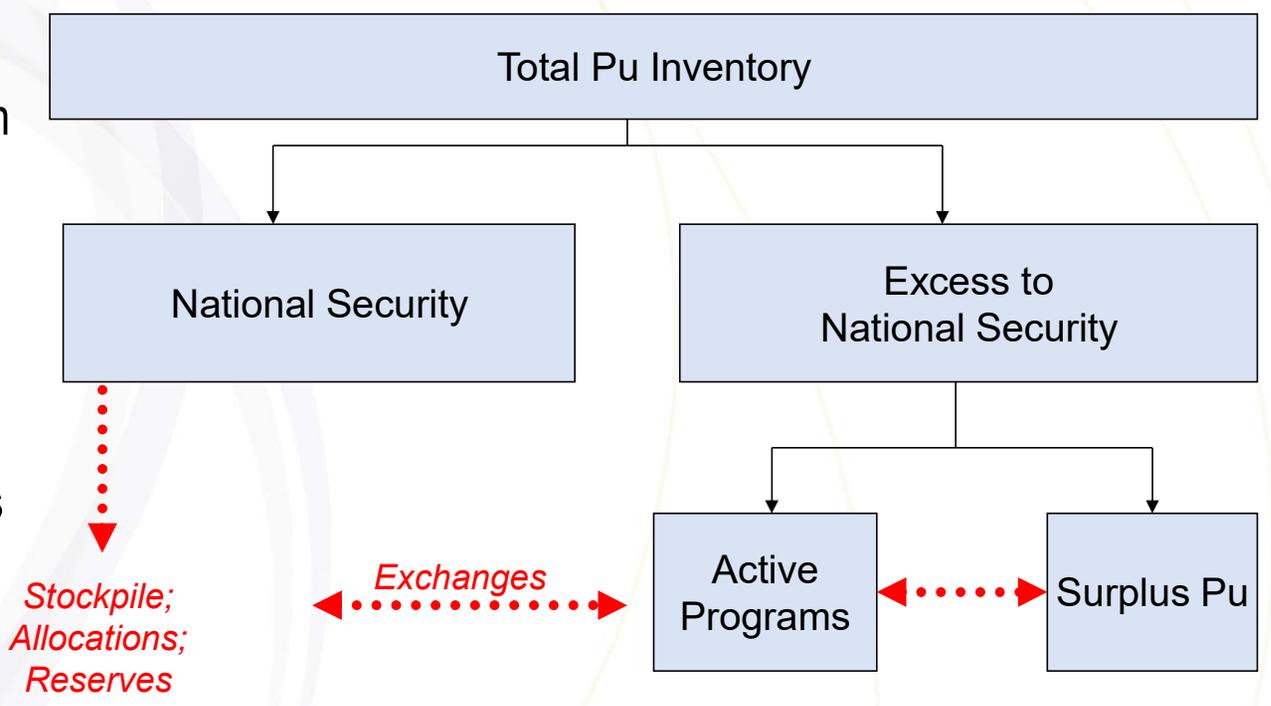
*Some of the 1.1 MT non-pit metal and oxide was not disposed at WIPP. The 6 MT non-pit metal and oxide is made up of 5.1 MT that was part of the Excess Plutonium Declarations and 0.9 MT that was not. The 0.9 MT non-pit metal and oxide is material that originated outside of the U.S. and thus was not considered with the Declarations. It was analyzed with the 5.1 MT non-pit metal and oxide in the 2015 SPD SEIS as 6 MT total.

Surplus Fissile Material Baseline

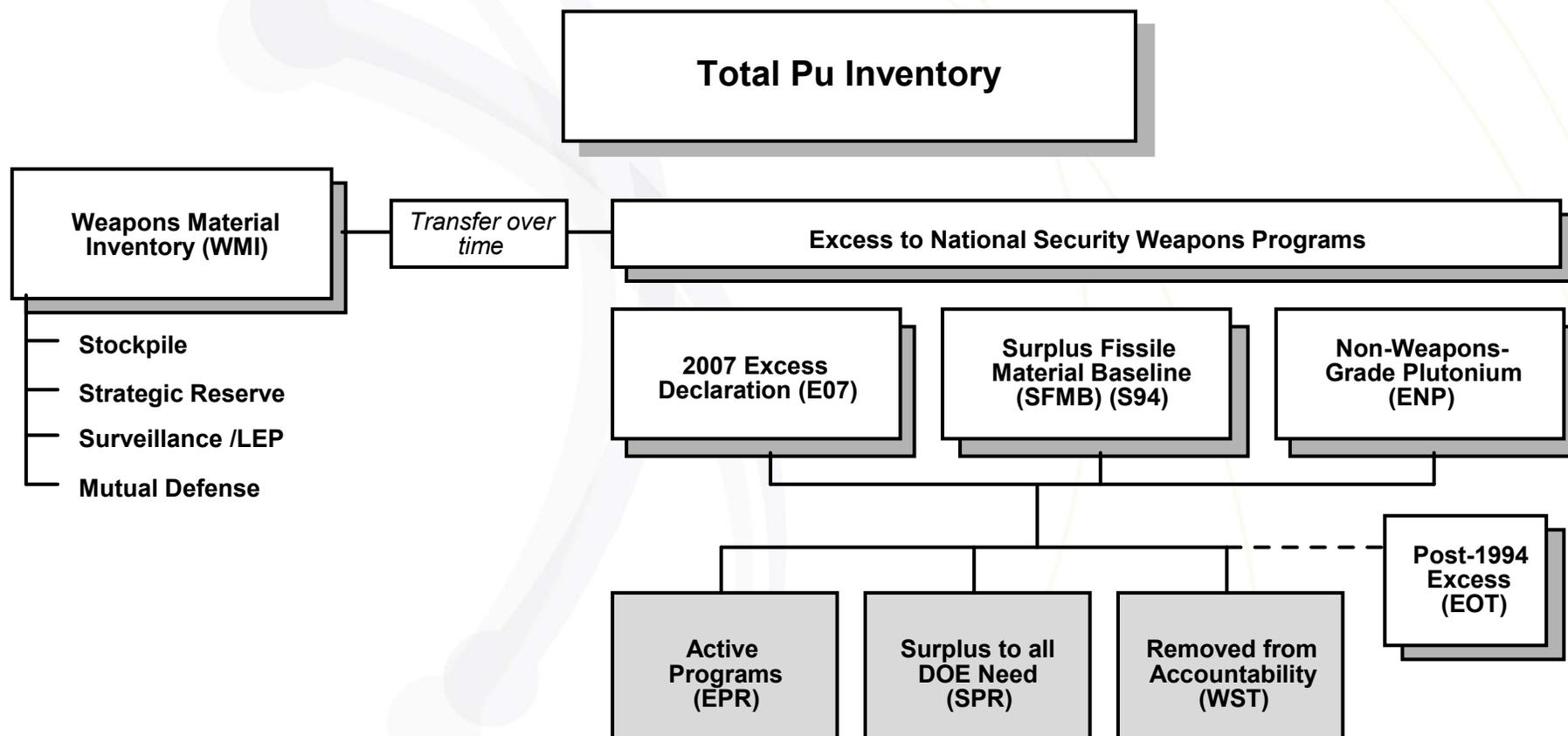
DOE/NNSA Method for Identifying and Tracking Excess Pu

Surplus Fissile Material Baseline

- After first Nuclear Materials Inventory Assessment (NMIA) was prepared at item level, all programs signed a Memorandum of Agreement in 2000 on categorization and tracking
- Issues for allocation and exchanges identify the need for revision and rebaselining
- Currently documented in Surplus Plutonium Reconciliation (SPuR) report



Notional SFMB Revision Structure



Verification of Plutonium Disposition

Reporting to Ensure Transparency in Meeting U.S. Policy

Verification in the Realm of Quantitative Materials Management

- The U.S. interactions with the international community strive to provide open reporting of “civilian” Pu, Excess quantities, and progress toward disposition (disposal or non-weapons programmatic use)
- *“Independent monitoring and verification of this process by the IAEA underscore U.S. confidence in a strong IAEA inspection regime and demonstrate U.S. commitment to transparency under Article VI of the Nuclear Nonproliferation Treaty.”*
- For 34 MT that was assigned to the MOX cycle, the U.S.-Russian PMDA specified a goal of IAEA verification, possibly coupled with bilateral monitoring. In 2016, Secretary Moniz announced to IAEA that the U.S. would seek to add 6 MT of additional Pu that was outside the MOX designation, making a commitment to “verifyingly eliminate 40 metric tons”
- NNSA and DOE are negotiating protocols with IAEA for physical tracking and non-destructive assay (NDA) of diluted product produced by dilute-and-dispose at SRS, followed by tracking as “blend cans” are transferred in Criticality Control Overpacks (CCOs) to WIPP

Additional Verification Challenges

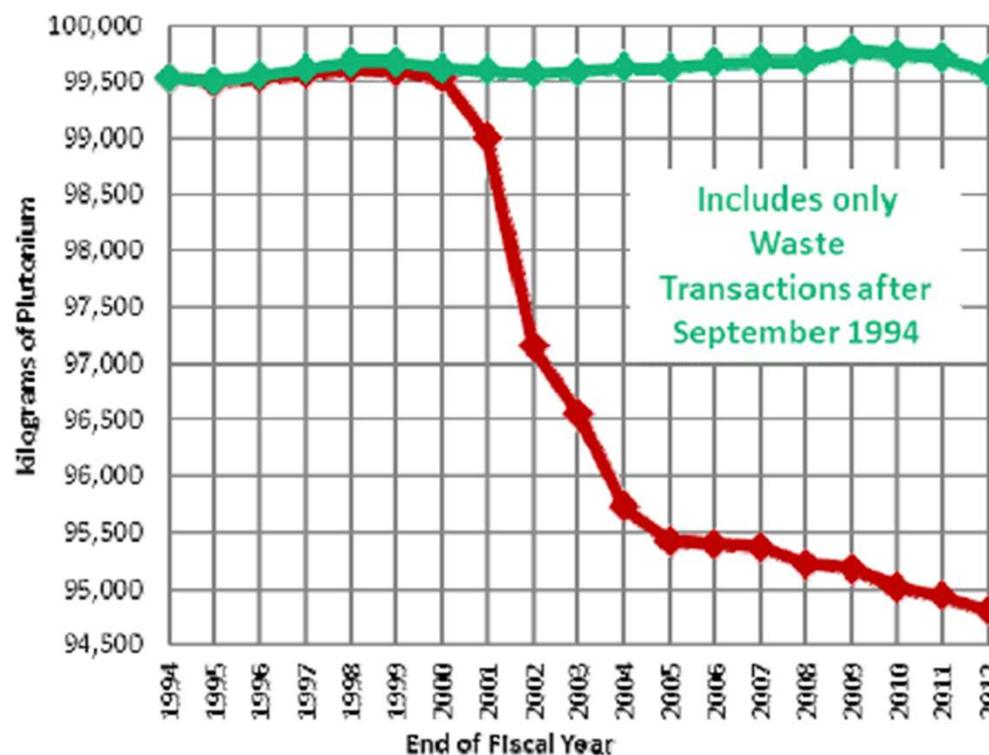
- The 40 MT of Pu that will be processed via dilute-and-dispose via SRS and WIPP does not span the entire 61.9+ MT of Excess, including:
 - About 5 MT previously disposed to transuranic and high-level waste
 - About 4 MT from the Zero Power Physics Reactor
 - 7.1 MT of pit-origin material from the 2007 declaration that is not part of the 34 MT
 - Pu in DOE-owned spent fuel, incidental waste, non-weapons-programmatic use, and radioactive decay
- The SRS/WIPP product in CCOs is highly diluted and adulterated from original “bulk” materials, making NDA potentially less precise than previous measurements, both destructive and non-destructive
- The bulk materials were identified through the NMMSS system and have been continually monitored and reported in Nuclear Materials Inventory Assessment, national and site records, and the Surplus Plutonium Reconciliation

Using the NMMSS System of Record to Verify Transfers & Evolution

- NMMSS is “transactions-based”, i.e., a quantity managed under Nuclear Materials Control and Accountability is assigned different attributes if it is processed, changed in form, subdivided, or transferred between locations and programs.
- For most of the past, all Pu that was removed from accountability (usually through the termination of safeguards process for disposal to waste) was transferred to a “VRIS” account, which can be tracked cumulatively over time.
- The SPuR and other studies demonstrate that the quantities assigned to the declarations can be tracked effectively to 2024

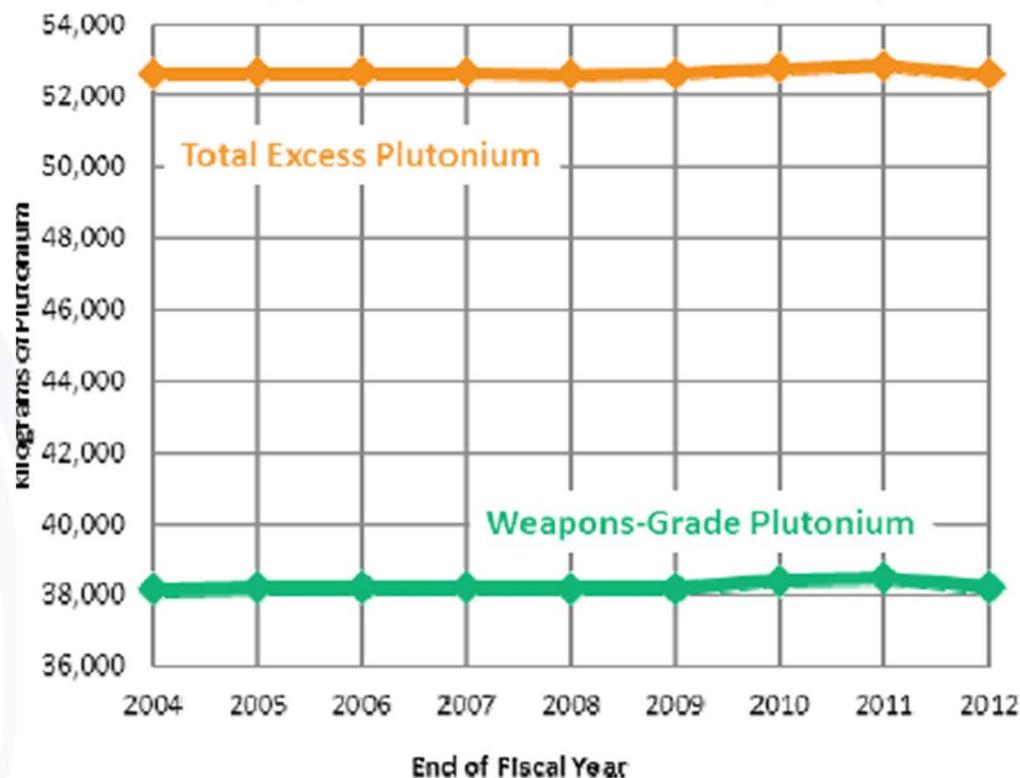
Tracking Total U.S. Accountable Plutonium Since 1994

- Chart shows that the accountable Pu inventory (99.5 MT in Sept. 1994 per Pu The First 50 Years) indeed has declined, but VRIS accumulations since 1994 account for them.
- (Analysis is completed through the end of FY2022, but this chart was previously approved for public release.)



Tracking Excess Plutonium (WG and non-WG) Since 2004

- Including active accounts and Pu removed from accountability into VRIS accounts, the 52.5 MT of S94 (1990s) declarations is shown.
- (The 9 MT declared in 2007 has not been formally identified at the item level; this commitment for future withdrawals is thus not shown.)



Potential Verification

- NMMSS records include transactions back to the first designations, including Pu that is already disposed, decayed, or added to inventory
- Using accountability records as a primary verification method or supplementary to partial accounting measurements, for dilute-and-dispose product only, would provide a “like for like” tracking system
- Items designated as Excess were generally “booked” into NMC&A based on measurements on more highly concentrated fissile material and may be more precise, even if new measurements are adequate
- NMMSS and NMIA reporting for government-owned “civilian” (Excess) separated Pu, and NMMSS reports for unseparated Pu in spent fuel at NRC sites are the primary input to U.S. contribution to IAEA Information Circular 549, *Management of Plutonium*.

Waste Tracking

Influence of New Protocols and NMC&A Order

Continued Tracking of “Disposed” Materials

- DOE Order 474.2A, *Nuclear Material Control and Accountability*, established revised protocols for tracking nuclear materials that were previously awarded Termination of Safeguards status and removed from quantitative accountability.
- For plutonium, very little disposition has occurred since 2010, but removal of the Excess inventory is accelerating at SRS and other sites.
- The implementation of IAEA verification will follow measurements at SRS (and potentially other sites) through tracking and emplacement at WIPP.
- New issues may develop for how quantitative nuclear materials inventory management will blend and supplement physical verification of sealed items.

Partial List of Interprogram and Integration Initiatives

- Update Surplus Fissile Material Baseline (SFMB) process and rebaseline Excess Pu and HEU if agreed.
- Evaluate recurring program of using NMMSS systems for long-term tracking and verification reporting, instead of “ad hoc” reports.
- Consider preparation of an update to *Plutonium: The First 50 Years* and its 2011 update, discussing changes in inventories, disposition pathways, priorities, and issues. Also update discussion of Foreign Obligations.

Additional Summary Conclusions from Headquarters

- More transparency and interaction is needed among sites and programs to ensure commitments and tools for reporting are compatible and consistent.
- SFMB needs procedures revised (from 2000 vintage) for consistency.
- DOE/NNSA should document institutionalized process/procedures (including flow-down of reports to sites to ensure consistent process/configuration management/reporting) in DOE Order 410.2, *Nuclear Materials Management*.
- We should maintain the information so that history is not lost.